Amendments to the Drawings:

The attached sheet of drawings includes changes to Figure 1-6. This sheet replaces the original Figures 1-6. Figure 6 has been designated as --Prior Art--. Formals drawings are submitted herewith under separate Letter to the Draftsperson which incorporate the changes required by the Examiner. Approval by the Examiner is respectfully requested.

Attachment: Replacement Figures1-6
Annoted Sheet Showing Changes to Figure 6

REMARKS

Claims 1-14 were pending in the application. Claims 1, 4-9, 11-14 stand rejected. Claims 2-3 and 10 stand objected to. Claim 2 was amended. Claims 15-20 were added. Claims 1-20 remain in the application.

The drawings were objected to under 37 CFR 1.83(a) and have been corrected.

Claims 1, 4,7-9 and 13-14 stand rejected under 35 U.S.C. 103(a) as being unpatentable over a combination of Szeliski et al. (US 6,044,181) and Huber (automatic 3D modeling using range images obtained from unknown viewpoints---IDS; hereafter "Huber"). The rejection states in relation to Szeliski:

> "With regard to claim 1, which is representative of claim 9, Szeliski discloses a method for deriving a three-dimensional model of a scene from a plurality of images of the scene (figures 1-3), said method comprising:
>
> "(a) generating a plurality of three-dimensional panoramic images of a scene (figures 2-3; column 4, lines 45-65);
>
> "(b) determining transformations that align the plurality of three-dimensional panoramic images (figures 4-5, also see column 13 line 25 to column 14 line 45);
>
> "(c) integrating spatial information from the plurality of three-dimensional panoramic images to form a spatial three-dimensional model of the scene (figures 1 and 2B; environment/ texture map memory 270 stores a 3-D model);
>
> "(d) integrating intensity (column 17, lines 12-25) [It is believed column 27, lines 12-25 was intended here] and texture information (figure 2B) from the plurality of three-dimensional panoramic images (figure 3) onto the spatial three-dimensional model to form a three-dimensional model of the scene (270 in figure 2B) containing both spatial and intensity information (figures 11-12)."

Szeliski does not support the rejection. The rejection argues that Szeliski discloses steps (a)-(d) of the method of Claim 1, but, in relation to step (a), cites portions of Szeliski directed to the entirety of the method of Szeliski. The rejection states:

"(a) generating a plurality of three-dimensional panoramic images of a scene (figures 2-3; column 4, lines 45-65);

The cited portion of Szeliski (part of the Summary of the Invention) states:

"<u>The invention</u> can be used to create full view panoramic mosaics from image sequences. Unlike current panoramic stitching methods, which usually require pure horizontal camera panning, <u>the disclosed system</u> does not require any controlled motions or constraints on how the images are taken (as long as there is no strong motion parallax). For example, images taken from a hand-held digital camera can be stitched seamlessly into panoramic mosaics.

"By taking as many images as needed, image mosaics can be constructed which cover as large a field of view as desired, e.g., a complete environment map. Because the image mosaics is represented in the invention using a set of transforms, there are no singularity problems such as those existing at the top and bottom of cylindrical or spherical maps. <u>This method</u> is fast and robust because it directly recovers 3D rotations instead of general 8 parameter planar perspective transforms. By mapping the mosaic onto an arbitrary texture-mapped polyhedron surrounding the origin, the virtual environment can be viewed or explored using standard 3D graphics viewers and hardware without requiring special-purpose players." <u>(emphasis added)</u>

Figures 2A-3 are similar in scope. (See Szeliski, col. 7, lines 14-16 and col. 9, lines 30-36)

In addition to arguing the entire method of Szeliski in relation to step (a) of the method of Claim 1, the rejection also argues that parts of Szeliski disclose steps (b)-(d) of the method of Claim 1. Taken together, the argument in the rejection requires support in Szeliski for performing the disclosed method, followed by repeating the parts of Szeliski cited in relation to steps (b)-(d) of the method of Claim 1. Absent that support, Applicants request that the rejection be withdrawn.

Szeliski also does not teach or suggest step (a) of Claim 1. Claim 1 requires:

"(a) generating a plurality of three-dimensional panoramic images of a scene".

Szeliski discloses the preparation of panoramic <u>mosaic</u> images:

> "The focal length estimation method and apparatus claimed in this application align plural overlapping images with one another for constructing an image mosaic." (Szeliski, abstract)

The panoramic mosaics of Szeliski lack depth information:

> "Image-based rendering is a popular way to simulate a visually rich tele-presence or virtual reality experience. Instead of building and rendering a complete 3D model of the environment, a collection of images is used to render the scene while supporting virtual camera motion." (Szeliski, col. 1, lines 15-19)
>
> "<u>The present invention is particularly directed to image-based rendering systems without any depth information</u>, i.e., those which only support user panning, rotation, and zoom." (Szeliski, col. 1, lines 26-28; <u>(emphasis added)</u>
>
> "The specification discloses how to solve the problem of loss of detail or image ghosting is solved by computing local motion estimates (block-based optical flow) between pairs of overlapping images, and using these estimates to warp each input image so as to reduce the misregistration. <u>This is less ambitious than actually recovering a perspective depth value for each pixel</u>, but has the advantage of being able to simultaneously model other effects such as radial lens distortions and small movements in the image." (Szeliski, col. 4, lines 4-12)

The panoramic mosaic images of Szeliski can be projected onto a three-dimensional surface for viewing:

> "The system can use a postprocessing stage to project such mosaics onto a convenient viewing surface, i.e., to create an environment map represented as a texture-mapped polyhedron surrounding the origin." (Szeliski, col. 3, lines 63-67; also note the 3-D model (polyhedron) in item 270 of Figure 2B along with a 2-D texture map)

The polyhedron is arbitrary, but allows use of a 3-D viewer. (Szeliski, col. 32, lines 34-37) The addition of arbitrary 3-D information (the polyhedron surface) does not turn a panoramic mosaic into a three-dimensional panoramic image.

Szeliski teaches against step (b) of Claim 1. Claim 1 requires:

"(b) determining transformations that align the plurality of three-dimensional panoramic images".

The rejection relies upon Figures 4-5 and a section of Szeliski that has the heading: "Incremental 3-D Rotational Alignment". (Szeliski, Figures 4-5, and col. 13, line 25 to col. 14, line 45). In relation to incremental alignment, Szeliski does not teach aligning a plurality of three-dimensional panoramic images or even mosaic images, but rather aligning each 2-D image used to make a mosaic with the growing mosaic image or, for speed, with another 2-D image:

"Incremental Alignment

"In the invention, image mosaics are represented as collections of images with associated geometric transformations. The first stage of the mosaic construction method computes an initial estimate for the transformation associated with each input image. This is done by processing each input image in turn, and finding the best alignment between this image and the mosaic constructed from all previous images. (To speed up this part, one option is to register with only the previous image in the sequence.)" (Szeliski, col. 9, lines 8-17; also see discussion of Figure 4-5 at col. 9, lines 36-53)

Szeliski's incremental alignment, 2-D image by 2-D image, is unlike Claim 1, which requires aligning a plurality of three-dimensional panoramic images, each derived from a plurality of range images.

Szeliski does not teach step (c) of Claim 1. Claim 1 requires:

"(c) integrating spatial information from the plurality of three-dimensional panoramic images to form a spatial three-dimensional model of the scene".

The rejection relies upon Figures 1 and 2B and states that

"environment/texture map memory 270 stores a 3-D model".

Szeliski does not teach formation of a spatial three-dimensional model.

Summarizing the portions of Szeliski quoted above in relation to Claim 1 step (a):

"Instead of building and rendering a complete 3D model of the environment, a collection of images is used to render the scene ..." (See Szeliski, col. 1, lines 15-19 at lines 17-19)

"The present invention is particularly directed to image-based rendering systems without any depth information" (Szeliski, col. 1, lines 26-27; see lines 26-28)

"The specification discloses how to solve the problem of loss of detail or image ghosting ... This is less ambitious than actually recovering a perspective depth value for each pixel ..." (Szeliski, col. 4, lines 4-12 at lines 4-5 and 8-10)

The 3-D model of item 270 is a general 3-D object onto which the mosaic image is mapped in postprocessing. (Szeliski, col. 32, lines 20-22; col. 3, lines 63-67) Szeliski states:

"The shape of the model and the embedding of each face into texture space are left up to the user. This choice can range from something as simple as a cube with six separate texture maps, to something as complicated as a subdivided dodecahedron, or even a latitude-longitude tessellated globe." (Szeliski, col. 27, lines 44-49)

The model of Szeliski is not a model of the scene. The mosaic image after mapping is still a mosaic image.

Szeliski does not teach step (d) of Claim 1. Claim 1 requires:

"(d) integrating intensity and texture information from the plurality of three-dimensional panoramic images onto the spatial three-dimensional model to form a three-dimensional model of the scene containing both spatial and intensity information."

Szeliski does not integrate intensity and texture information from three dimensional panoramic images. Szeliski maps from a 2-D texture map:

"FIGS. 27 and 28 illustrate a cubic 3D model and corresponding 2D texture map for carrying out one embodiment of a texture mapping method.

"FIG. 29 illustrates a mapping between triangular vertices of a 3D model and a 2D texture map employed in carrying out one embodiment of the texture mapping.

"FIGS. 30 and 31 illustrate a spherical 3D model and corresponding 2D texture map for carrying out one embodiment of the texture mapping method." (Szeliski, col. 6, lines 20-29)

As earlier discussed, there is also no 3-D model of the scene in Szeliski, just a mosaic image.

The rejection states in relation to the combination of Szeliski and Huber:

> "Szeliski is silent about range images as claimed. Huber, in the same field of endeavor of automatic 3D modeling using range images obtained from unknown viewpoints (title) and same problem solving field of range image information disclose the use of range images. In particular, Huber constructs a 3D model from a plurality of range images using a surface matching algorithm. It would have been obvious to a person of ordinary skill in the art at the time of the invention was made to modify Szeliski by using range images in creating 3D panoramic image model as taught by Huber because such a modification will allow a system to create an automatically 3D model of a scene from a set of range images obtained from unknown viewpoints as mentioned Huber in the title and also at least in the abstract."

The cited motivation supports use of Huber without Szeliski. As noted in the application:

> "Huber's algorithm for 3-D modeling generates a 3-D model from a series of range images, assuming nothing is known about the relative views of the object." (application, page 2, lines 17-19)

Why would one of skill in the art not use the existing solution to problem: the method taught by Huber?

Szeliski also teaches or suggests, that depth information could be provided by adding a depth map to a completed mosaic image:

> "Instead of building and rendering a complete 3D model of the environment, a collection of images is used to render the scene while supporting virtual camera motion. For example, a single cylindrical image surrounding the viewer enables the user to pan and zoom inside an environment created from real images. More powerful image-based rendering systems can be built by adding a depth map to the image or by using a larger collection of images." (Szeliski, col. 1, lines 17-25)

Why would one of skill in the art ignore this teaching or suggestion of how to add depth (range) information and instead look to Huber?

Assuming for the sake of argument that Szeliski and Huber could be combined, that combination would present the same shortcoming as Huber. The application describes this:

> "Huber's algorithm for 3-D modeling generates a 3-D model from a series of range images, assuming nothing is known about the relative views of the object. It can be broken down into three phases: (1) determining which views contain overlaps, (2) determining the transformation between overlapping views, and (3) <u>determining the global position of all views</u>." (application, page 2, lines 17-21; <u>emphasis added</u>)
>
> "Once the overlapping views and local transformations are estimated, step (3) of Huber's algorithm entails using a series of consistency measures in combination with a model graph to find any inconsistencies in the local transformations. Huber recognizes, however, that <u>there are computational costs in scaling his technique to a large number of views. For that reason, the computational cost of step (3) can grow prohibitively expensive as the number of input range images gets large</u>." (application, page 3, lines 13-19; <u>emphasis added</u>)

Szeliski, as discussed above, uses a similar incremental, image-by-image alignment method. (Szeliski, col. 9, lines 8-17; also see discussion of Figure 4-5 at col. 9, lines 36-53) The combination of Szeliski and Huber would still lack the advantage provided by the claimed invention:

> "The advantage of this invention is that the use of the 3-D panoramic images drastically simplifies the merging process compared to merging the entire set of individual range images. This invention enables a complete 3-D surface description to be easily derived for an arbitrary physical scene." (application, page 5, lines 10-14)

In relation to this, Claim 1 states:

> "(b) determining transformations that align the plurality of <u>three-dimensional panoramic images</u>;
>
> "(c) integrating spatial information from the plurality of <u>three-dimensional panoramic images</u> to form a spatial three-dimensional model of the scene; and
>
> "(d) integrating intensity and texture information from the plurality of <u>three-dimensional panoramic images</u>".

Claims 4 and 7-8 are allowable as depending from Claim 1 and on the same basis as Claim 1.

Claim 9 is allowable on the grounds discussed above in relation to Claim 1.

Claims 10 and 13-14 are allowable as depending from Claim 9.

Claims 5 and 11 stand rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Sezliski and Huber as applied to claim 1, and further in view of Nayar et al. (US 4,912,336).

Claims 5 and 11 are allowable as depending from Claims 1 and 9, respectively.

Claims 6 and 12 stand rejected under 35 U.S.C. 103(a) as being unpatentable over a combination of Szeliski and Huber as applied to claims 1, 4, 7-9 and 13-14 and further in view of applicant's admitted prior art in the specification at page 10, lines 4-14.

Claims 6 and 12 are allowable as depending from Claims 1 and 9, respectively.

Added Claim 15 is supported by the application as filed, notably the original claims and at page 7, lines 3-5 and 16-21 and is allowable on the same basis as Claim 1.

Added Claims 16-17 are supported on the same basis as Claim 15 and are allowable as depending from Claim 15.

Added Claim 18 is supported and allowable on the same grounds as Claim 15.

Added Claims 19-20 are allowable as depending from Claim 18. Claim 19 is supported by the application as filed, notably original Claims 4 and 10. Claim 20 is supported by the application as filed, notably at page 9, lines 8-12.

It is believed that these changes now make the claims clear and definite and, if there are any problems with these changes, Applicants' attorney would appreciate a telephone call.

In view of the foregoing, it is believed none of the references, taken singly or in combination, disclose the claimed invention. Accordingly, this application is believed to be in condition for allowance, the notice of which is respectfully requested.

Respectfully submitted,

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Enclosures: Replacement Drawings Figures 1-6
Letter to the Draftsperson
Copies of Formal Drawings 1-6
Annotated Drawing, Figure 6

If the Examiner is unable to reach the Applicant(s) Attorney at the telephone number provided, the Examiner is requested to communicate with Eastman Kodak Company Patent Operations at (585) 477-4656.

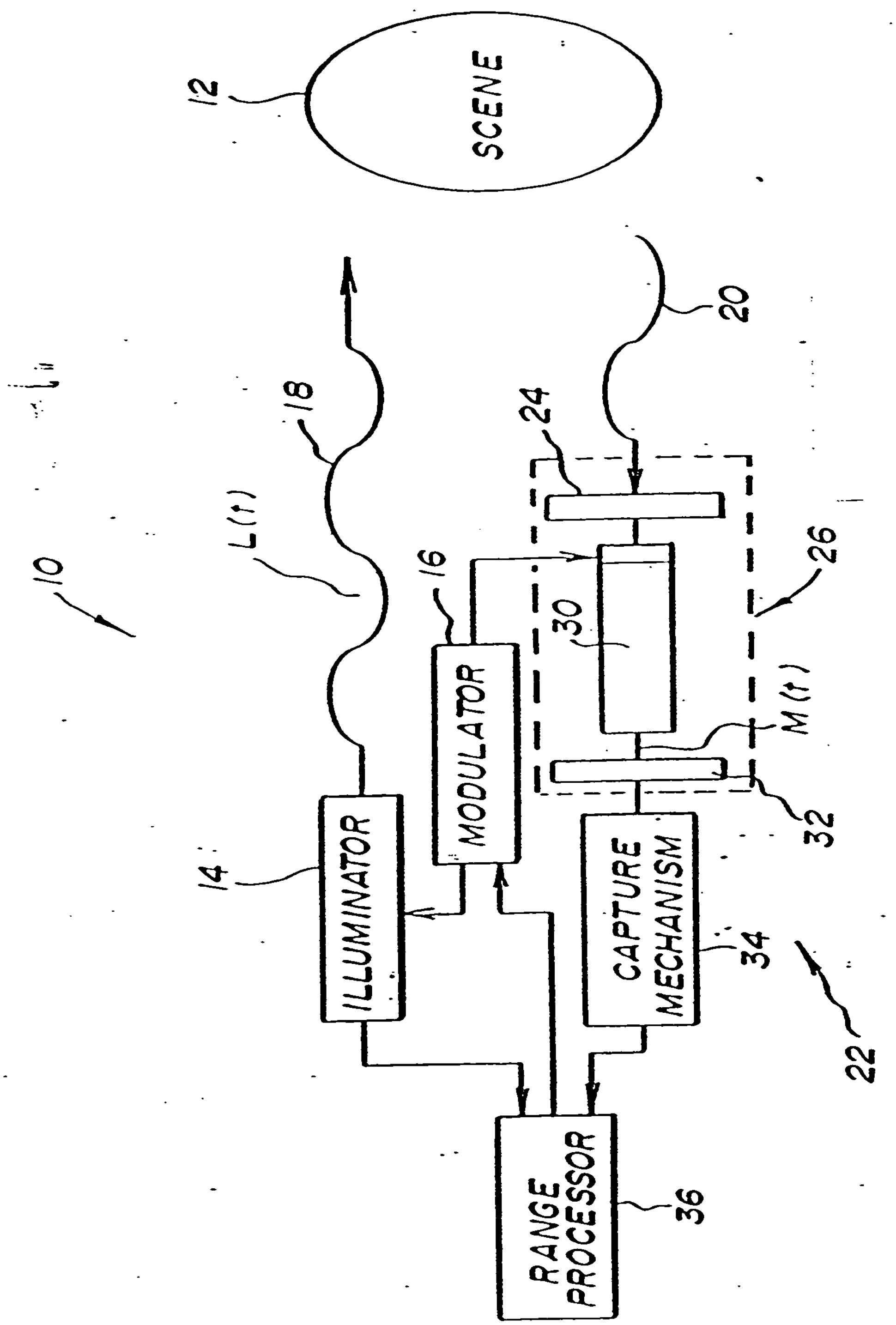

FIG. 6
(PRIOR ART)